AEOD TECHNICAL REVIEW REPORT*

UNIT: Fort Calhoun
DOCKET NO.: 50-285
LICENSEE: Omaha Public Power District
NSSS/AE: Combustion Engineering/Gibbs & Hill

TR REPORT NO. AEOD/T302
DATE: February 9, 1983
EVALUATOR/CONTACT: E. V. Imbro

Subject: Postulated Loss of Auxiliary Feedwater System Resulting From Turbine Driven Auxiliary Feedwater Pump Steam Supply Line Rupture

Event Date: May 20, 1982

Summary

The potential for total loss of the auxiliary feedwater (AFW) system was identified by the licensee when it was discovered that the present side by side configuration of the AFW pumps make them vulnerable to a common caused failure; the passive failure of the steam supply to the turbine-driven AFW pump may result in failure of the motor-driven pump since it is not qualified to operate in a harsh steam environment. A review by NRR concluded that the Ft. Calhoun AFW design meets current acceptance criteria and the licensee's postulated scenario of a loss of offsite power followed by the passive failure of the steam supply line to the turbine-driven AFW pump, resulting in possible failure of both pumps, was outside the scope of the staff's review and did not represent a credible accident scenario. The concern of this office is that a single passive failure, albeit one of low probability, totally disabling the AFW system and the plant's ability to achieve safe shutdown, hot or cold, with safety-related equipment is permissible under present criteria.

Discussion

As a result of reviewing a report (Reference 1) prepared by the Institute of Nuclear Power Operations (INPO), Fort Calhoun submitted LER 82-012 which identified a concern that the harsh environment created by the rupture of the steam supply line to the turbine-driven auxiliary feedwater (AFW) pump could cause the failure of the motor-driven AFW pump in addition to rendering inoperable the turbine driven pump. This common cause failure, recognized by the licensee after review of the INPO report, results from the side-by-side AFW pump arrangement and the fact that the motor-driven AFW pump is not qualified for the potentially harsh steam environment. The licensee's concern was that the AFW system would not be functional following a loss of offsite power if the passive failure of the steam supply line to the turbine-driven AFW pump was concurrently postulated as the "single failure." This scenario results in a reactor trip and the loss of normal and auxiliary feedwater. Under these circumstances the steam generators boil dry in approximately 20 minutes and it would be necessary to rely on "feed and bleed" using the PORVs and HPSI pumps to cool the reactor core.

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* This document supports ongoing AEOD and NRC activities and does not represent the position or requirements of the responsible NRC program office.

The steam supplied to the turbine-driven AFW pump can be taken from either of the two main steamlines. These two-inch supply lines for the turbine driven AFW pump join to form a single two-inch line in Room 81, adjacent to the control room. From Room 81, the supply header continues on into Room 19 where both AFW pumps are situated. The two steam supply headers in Room 81, i.e., those coming from the main steamlines, are each provided with a normally closed air-operated isolation valve. Normally open hand-operated "warmup valves" bypass the air-operated valves to maintain the steam supply lines at operating temperature. The warm-up valves also located in Room 81 are one-half inch. Therefore, the steam flow into Room 19 following the postulated rupture of the two-inch steam supply header would be restricted by the size of the flow path through the warm-up lines when the pump was idle. Further, Room 19 will be monitored by a plant security system TV camera during the operation of the turbine-driven AFW pump. Operators would also be alerted to a steam release in Room 19 by the fire annunciation circuits actuated by ionization-type detectors. Therefore, the high energy line break postulated by the licensee could be quickly detected and isolated either from the control room or locally by closing the steam isolation valves in Room 81 which is immediately adjacent to the control room.

While noting the above consideration, in their review, i.e., rapid break detection and isolation, the NRR acceptance of this situation was primarily predicated on the fact that the scenario postulated by the licensee goes beyond the current licensing design bases as it involved loss of offsite power and a pipe break, both of which are considered initiating events.

Findings

Guidelines for the review of pipe breaks presented in Section 3.6.1 of the Standard Review Plan (SRP), NUREG-0800, specify that:

1. ... each longitudinal crack or circumferential break in high-energy fluid system piping or leakage crack in moderate energy fluid system piping should be considered separately as a single postulated initial event occurring during normal plant conditions;

2. Offsite power should be assumed to be unavailable if a trip of the turbine-generator system or reactor protection system is a direct consequence of the postulated piping failure; and

3. Protection of essential systems and components against postulated piping failures in high or moderate energy fluid systems that operate during normal plant conditions and that are located outside of containment, should be provided....

Note: Essential systems and components are defined in SRP 3.6.1 as follows: "Systems and components required to shut down the reactor and mitigate the consequences of a postulated piping failure, without offsite power."

Based on the above SRP guidelines and given the fact that the licensee postulated pipe break is sufficiently small not to cause a reactor trip, it follows that there is no resultant loss of offsite power and the normal feedwater system can be presumed operable. Further, since a reactor shutdown is not required and the AFW system is not required to mitigate the consequences of the postulated pipe break, the AFW system is not considered "essential"

for this scenario. Therefore, under these circumstances the common caused failure of the AFW is considered acceptable under the present NRC guidelines for protection against the postulated piping failures in fluid systems outside containment.

Fort Calhoun, having begun commercial operation in September 1973, prompted a review of previous staff guidance on pipe breaks provided by the A. Giambusso letter and the J. F. O'Leary letter Appendices B and C respectively to SRP 3.6.1. These documents, although they required no loss of redundancy as a result of the pipe break in systems required to mitigate the consequences of the postulated pipe break and safely shut down the reactor, also seemed to focus on the protection of structures, systems, and components required for safe shutdown from the effects of a high-energy pipe break irrespective of whether the postulated pipe break necessitated a plant shutdown. In this regard the former guidance was more conservative, by my interpretation, to that being presently used. This is illustrated below by the following excerpts from the Giambusso and O'Leary letters, Appendices B and C to SRP 3.6.1 referred to above.

> .... where pipes carrying high energy fluids are routed in the vicinity of structures and systems necessary for safe shutdown of the nuclear plant, supplemental protection of those structures and systems shall be provided to cope with the environmental effects (including the effects of jet impingement) of a single postulated open crack at the most adverse location(s) with regard to those essential structures and systems... (Appendix B to SRP 3.6.1)
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> Where both isolation by remote location and enclosure in protective structures are impracticable, systems containing high-energy fluids, or portions of the systems, are provided with restraints and protective measures such that the operability and integrity of structures, safety systems, and components that are required to shut down the reactor safely and maintain the plant in a cold shutdown condition are not impaired. (Appendix C to SRP 3.6.1)

Qualification of the AFW motor driven pump is one way the licensee could assure system function.

Conclusions

The AFW system, in my opinion, is probably the most versatile and vital of the plant safety systems. It is typically used during normal plant operation, i.e., startup and shutdown, as well as in the mitigation of postulated events such as; main steamline break, small break loss of coolant accident, loss of feedwater, steam generator tube rupture, and loss of offsite power. So crucial is the availability of this system during a loss of offsite power that it is required by the staff to have at least two full-capacity independent systems powered by diverse sources and is the only safety system designed to function during a total loss of AC, loss of offsite power and failure of the redundant onsite emergency AC power. Further, it is the only safety system for which a reliability analysis must be performed demonstrating an unreliability in the range of 10^{-4} to 10^{-5} per demand.

The Fort Calhoun AFW system meets the NRC's present design and reliability acceptance criteria and in fact may also be acceptable, even postulating that the pipe break results in a reactor trip, on some other defined basis (e.g., low steam flow due to choked flow conditions in the warm up line or that rapid break detection and isolation prevent degradation of the motor driven AFW pump.

References

1. INPO/NSAC Significant Operating Experience Report 81-17, "Potential for Steam Line Rupture to Affect Auxiliary Feedwater System," dated, November 11, 1981.

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REMARKS

Richard Udell, House Oversight and Investigations Subcommittee, has requested a copy of the attached report.

Mr. Udell has been in contact with Fred Combs in Congressional Affairs.

Would appreciate it if you would forward this on to him.

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